EXECUTIVE SUMMARY

Recent legislation has deregulated the telecommunications industry, and other industries may follow. This legislation, along with technical innovations, promises to provide the City of Anaheim and it's citizens a wide array of new services. However, new technology and increased competition will require the construction of extensive new facilities in Anaheim.

The Department of Public Works and other City departments have been assessing the potential impacts of these anticipated facilities. One of the biggest impacts anticipated is a substantial increase in the number of cuts experienced in our city streets and the resulting deterioration of the pavement. The Negative Declaration on Environmental Impact adopted by the Public Utilities Commission, when approving the installation of telecommunication facilities throughout the state, also identified utility cuts and the subsequent deterioration of the street as a significant impact of the project

Public Works has taken two steps to address these impacts. First, the Department's trench restoration standards have been updated and will be strictly enforced to provide high quality trench restoration and resurfacing. Secondly, staff is recommending adoption of a Street Deterioration Fee to recover the long term costs associated with utility cuts. Both of these steps are necessary because studies have shown there is deterioration of the street even with the highest trench restoration standards. The studies documenting these findings are included in Section 2 of this report

Four studies have been obtained which assess the impacts of utility cuts on the service life of pavement. These studies were completed by experts in the field of pavement design, universities, local agencies and the American Public Works Association. The studies utilized different methods of analysis, and the studies took place across the country in a variety of climates and soil conditions. However, all four studies concur in their conclusions: Utility cuts significantly reduce the life of street pavement

A significant increase in the number of utility cuts, without additional funds for maintenance, will dramatically increase the existing deficiencies in the City's street system. Adoption of the proposed fee will provide funds to the street maintenance program which could maintain the City's existing maintenance level, without additional monies from the General Fund. Failure to recover the costs associated with utility cuts will result in significant deterioration of the streets over time and require additional funding for the street maintenance program.

The City of Phoenix, Arizona has had a similar fee in place since 1987. This fee has withstood a court challenge by the local gas company. Although a settlement agreement was reached before a final court decision, the settlement agreement retained the fee. The extensive discovery process resulting from the litigation failed to repudiate the findings of Phoenix's pavement deterioration study. The City of Anaheim Street Deterioration Fee program is modeled after that of Phoenix. However, it has been adjusted to actual costs of construction in our area Details for establishment of the recommended fee schedule can be found in Section 3.

STREET DETERIORATION FEE
CITY COUNCIL WORKSHOP
AUGUST 15, 1995

BACKGROUND

The public street system is one of the City's most visible and valuable assets. The City owns and maintains 616 miles of pavement with a value of over $388 million. During fiscal year 1994-95 the City spent $4.2 million maintaining the street system, and that was just to keep pace with the current deficiencies.

The arterial street system alone has a current maintenance deficiency of over $52 million. And, although we have been quite successful in obtaining grants to supplement the City's funding program, it still is not enough. It would require expenditures of nearly $10 million dollars per year for 10 years to bring all the pavements up to an excellent rating. Expenditures of $8 million per year could bring the streets up to an acceptable level. But current funding levels ($4.2 million) have not reduced the level of deficiencies, the quality of the streets overall have remained unchanged.

As we look to the future of street maintenance and quality, two significant issues emerge. First, some of our current funding sources may be threatened by the County bankruptcy reducing our ability to keep up with current deficiencies. Second, and possibly more threatening, is the deregulation of telecommunications. As competition for these services increases, we can expect a number of companies to be cutting into the public streets to install their facilities. Studies have shown, the deterioration caused by these utility cuts will be immediate and will worsen over time.

About a year ago, it became apparent that Public Works must address this issue. How do we protect the City's streets and rights of way, while still allowing the City's businesses and residents access to the most up-to-date technology available? Deregulation and competition will provide our citizens advanced services at the lowest possible cost. But the impact to the streets could be devastating.

Studies have shown that utility cuts significantly reduce the life of the pavement, and not only at the location of the cut. This reduced life propagates beyond the area of the cut to the surrounding pavement. This costs the City millions of dollars in reduced pavement life.

If we fail to address and mitigate these impacts now, we will find dramatic increases in pavement deficiencies with no additional funding for the necessary repairs. The City, and it's residents, cannot afford to pay for this street deterioration caused by others. Contractors and utility companies who cut into the City's pavements have a responsibility to mitigate the impacts of those cuts.

STREET RESTORATION REQUIREMENTS

Utility companies who utilize the public right of ways are required by City ordinance and local franchise agreements to repair any damage caused by their operations and to restore the streets to as good a condition as before their excavation. The Gas Company franchise includes the following language.

> "If any portion of any street shall be damaged by reason of defects in any of the pipes and appurtenances maintained or constructed under this grant, or by reason of any other cause arising from the operation of existence of any pipes and appurtenances constructed or maintained under this grant, **said grantee shall, at its own cost and expense, immediately repair any such damage and restore such street or portion of street to as good a condition as existed before such defect or other cause of damage occurred**, such work to be done under the direction of the Engineer, and to his reasonable satisfaction."

These requirements are typical to other local franchise agreements. Even companies who operate without a local franchise, like Pacific Bell, are required to comply with local ordinances regarding the repair of any and all damage caused by their facilities. Most of the contractors and utility companies try to comply with these requirements, however studies show this cannot be done.

IMPACTS OF UTILITY CUTS

A study from the City and County of San Francisco states **"Utility cuts produce damage that propagates beyond the area excavated; even the highest restoration standards do not remedy all the damage. Utility cuts cause the soil around the cuts to be disturbed, cause the backfilled soil to be compacted to a different degree than the soil around the cut, and produce discontinuities in the soil and the wearing surface. Therefore, the reduction in pavement service life due to utility cuts is an inherent consequence of the trenching process."**

The future condition of the City's street system will be in jeopardy if the City does not require contractors and utility companies to truly mitigate their impacts and share in the cost of pavement maintenance and rehabilitation. The installation of citywide telecommunication facilities will likely result in nearly every street in the City to be cut at least once in the next five years. Several communication companies have already begun construction of fiber optic facilities in Anaheim. And as competition opportunities increase, we can expect more companies. The damage that the construction of these facilities will cause must be addressed now. We cannot afford to wait 5 to 10 years, when the streets are in disrepair, and then try to find the money for the necessary repairs. It is unlikely funds will be available for the extensive repairs which will be required.

STUDIES BY OTHER AGENCIES

To address this issue, the Public Works Department began to research available information and documentation. The following three studies on pavement deterioration were obtained which provided background information and analysis. Copies of these studies have been provided to City Council and the public for review.

THE EFFECTS OF UTILITY CUT PATCHING ON PAVEMENT PERFORMANCE IN PHOENIX, ARIZONA - City of Phoenix, Arizona, July 1990

THE EFFECT OF UTILITY CUTS ON THE SERVICE LIFE OF PAVEMENTS IN SAN FRANCISCO - City and County of San Francisco, May 1995

COSTING THE EFFECTS OF UTILITY CUTS IN THE LIFE CYCLE OF ASPHALT PAVEMENTS - Burlington, Vermont, September 1986

Although all reports provided similar conclusions, we did not rely on the Vermont study for specific data due to the extreme weather variations.

The Phoenix study assessed the surface condition and structural adequacy of 50 different street sections. The surface condition was quantified using the Pavement Condition Index (PCI) Method developed by the U. S. Corps of Engineers rating the difference in performance between utility patched and non-patched pavements. Structural adequacy of patched and non-patched pavements were rated using the Falling-Weight-Deflectometer.

For arterial streets the study revealed that, for non-patched areas, a PCI rated of 69 is obtained at 20 years and, for patched areas, this PCI is obtained at only 15.5 years. Since a PCI rating of 69 is the point at which rehabilitative measures are required, this study shows a reduced pavement life of 4.5 years. A graph of these findings is attached as Exhibit 1.

In addition to this reduction in pavement life, the results of the Falling-Weight-Deflectometer tests show the deflections in and around patched areas were 25% greater than non-patched areas. This results in the need for more extensive rehabilitation requirements. **The study concludes that the reduced pavement life, coupled with the increased rehabilitation in patched areas, results in doubling the cost of pavement maintenance to the city.**

The recently completed San Francisco study provides similar results, although their study parameters were modified. San Francisco utilized a Pavement Condition Score developed for their own Pavement Management System and divided pavements into three groups - streets with less than 3 cuts, streets with 3 - 9 cuts, and streets with more than 9 cuts. The test sections included both arterial and local streets. This rating system establishes a Pavement Condition Score of 65 as the end of the pavement life. This graph, attached as Exhibit 2, shows this pavement life to range from 26 years for pavements with less than 3 cuts to only 13 years in areas with more than 9 cuts.

The results were even worse for heavily traveled streets. For streets with a traffic index of 8, the pavement life was reduced from 26 years to 12 years. **The study also notes "The City and County of San Francisco has one of the most stringent trench restoration requirements in the country." But even the highest standards cannot mitigate the damage caused by these utility cuts.**

CITY OF ANAHEIM ANALYSIS

The results of the studies are clear. Utility cuts result in pavement deterioration and shorten the useful life of the pavement. Based on the results of the Phoenix study, the City's pavement management consultant, Infrastructure Management Services (IMS), was directed to assess the impacts of reduced pavement life on the cost of maintaining Anaheim's street system.

Arterial highways were evaluated first. With 6.2 million square yards of pavement and a replacement value of $212 million, the pavement replacement value is $34.19 per square yard. And with a design life of 20 years, the value per square yard per year is $ 1.71.

$$\text{Value / Square Yard} = \frac{\text{Total Value}}{\text{Total Square Yards}}$$

$$\text{Value / Square Yard} = \frac{\$212,000,000}{6,200,000\ \text{SY}} = \$34.19 / \text{SY}$$

$$\text{Value / SY / Year} = \frac{\text{Value / SY}}{\text{Average Design Life in Years}}$$

$$\text{Value / SY / Year} = \frac{\$34.19 / \text{SY}}{20\ \text{Years}} = \$1.71\ /\text{SY/YR}$$

Using a reduced pavement life of 4.5 years, the value of the reduced life is $7.70 per square yard

Value of Reduced Life = Life Reduction X Value/SY/Year

Value of Reduced Life = 4.5 Years X $1.71/SY/Year
= $7.70 / SY

From here an estimate of the pavement area effected by the cut needs to be determined. Although Phoenix assumed the entire street width (up to 33 feet) was effected, IMS was instructed by staff to assume a lane width (12 feet) for arterials. This assumption is based on the determination that adequate repairs could be designed and constructed for each lane or 12 foot width.

The cost impact per foot was calculated using this 12 foot width. The cost to the City for a utility cut in an arterial street less than one year old is $10.24 per lineal foot.

$$\text{Cost per Lineal Foot} = \frac{\text{Value of Reduced Life X Area Affected}}{1\ \text{Lineal Foot}}$$

and,
Area Affected = Pavement Width Affected X Lineal Feet of Cut

assuming a 12 foot width,
Area Affected = 12 Feet X 1 Foot = 12 Square Feet or 1.33 SY

Therefore,

$$\text{Cost per Lineal Foot} = \frac{\$7.70/\text{SY} \times 1.33\ \text{SY}}{1\ \text{Lineal Foot}} = \$10.24$$

Similar calculations for local streets were made using a design life of 35 years (which is a typical life for local streets) and a pavement width of 18 feet (half the width of a typical local street). The calculations show a cost to the City of $8.98 per foot for utility cuts in local streets less than one year old.

Based on this methodology, calculations were also done for arterial streets more than one year old up to 20 years old, and local streets more than one year old up to 35 years old.

PROPOSED ORDINANCE

Using these results, Public Works has developed a proposed Street Deterioration Fee to defray the costs of utility cuts. To recover the true costs as closely as possible, the proposed fee schedule is divided into arterial and local streets, and is staggered based on the age of the pavement. Costs for cutting into arterial streets range from $9.22 per lineal foot per lane width for streets less than 3 years old to no charge for streets over 15 years old. Local street range from $8.46 per foot to no charge. The proposed Street Deterioration Fee Schedule is attached as Exhibit 3. Although these costs may seem high, they are the true costs of utility cuts.

The proposal developed from these results has several key points. Generating funds for street reconstruction is not the primary goal of this proposal. The goal is to address and mitigate the damage done to City streets by utility cuts. We hope this proposal will encourage coordination between the utility companies and coordination with City projects. To this end, the proposed fee includes an exemption for cuts in streets scheduled for rehabilitation within one year. In addition, contractors and utility companies who can coordinate their work, resulting in only one street cut, will pay for only one street cut.

Another goal of this proposal is to reduce the number of street cuts required for the construction of telecommunication facilities. Therefore, this proposal would require the installation of 2 empty conduits when a company is installing telecommunication facilities in public streets. These conduits would be available for future connections to the information highway

The proposal would also restrict the use of the Street Deterioration Fees to ensure their availability at the end of the pavement life, when the funds are needed.

SURVEY OF OTHER AGENCIES

An informal survey of other cities has found a number of cities with the same concerns and assessing the same studies. Many cities are considering similar fees, however, no **local** cities have implemented fees for street cuts as of this date. A success story is the City of Phoenix who adopted street cut fees a number of years ago and has been successful against a legal challenge of the fee by a local utility company

In contrast to that is the City of San Diego who has allowed the telecommunication companies to move forward before the city had the opportunity to assess the potential impacts. San Diego is now living through the immediate impacts of disruption and degradation, and is beginning to realize what the long term impacts could mean to their street system. In response, city staff has drafted and will recommend an ordinance to implement street deterioration fees. However, much damage has already been done and San Diego may never have the funds to completely recover.

RECOMMENDED ACTION AND RESULTS

To avoid this situation in Anaheim we must take action now. The City of Anaheim will be one of the first cities in Orange County to have telecommunication facilities installed in our right of ways. If we choose to wait until other local cities have implemented similar fees, we will be too late. The damage will be done.

Of course we are also concerned with the impact this proposal could have on our local utility companies, but with cooperation and coordination we believe the impact can be minimized. To address the concerns of our local utility companies, a notice was sent with a copy of the proposed ordinance, including the fee schedule, to each of our local utility companies. They were invited to review the proposed ordinance and related studies, and I invited them to meet with me to discuss their questions and concerns. The notice was sent on June 16, 1995 to provide the companies adequate time to review the information. Although a number of the utility companies called with questions, only the Gas Company requested a meeting.

In general, the utility companies are concerned with the impact this may have on their cost of doing business and feel these fees may be covered in their franchise agreements. However, as was shown earlier, the franchise fees are not intended to cover damage to public facilities and these costs should be addressed independent of the franchise fees.

Several utility companies have also questioned how the City intends to deal with the impacts of it's own utility cuts and construction projects. The ordinance, as proposed, exempts utility cuts done in conjunction with City projects or within one year prior to pavement rehabilitation. This will exempt a large number of City projects since many of our subsurface projects are in conjunction with pavement rehabilitation. In addition, the Utilities Department provides a substantial Right of Way Fee to the City's General Fund which helps fund the City's street maintenance program. This Right of Way Fee is intended to pay for the impacts of the City's utilities within the public streets.

Adoption of the proposed ordinance and fee schedule would ensure that contractors and utility companies take responsibility for the impacts of their facilities. The Street Deterioration Fee would help ensure available funding for the repairs necessary due to the accelerated deterioration of the City's streets.

In addition, it is anticipated that the proposal will result in a decrease in the number of street cuts required by contractors and utility companies. It will be financially advantageous to coordinate with other utility companies or with City projects. We may also find that some companies will implement alternative methods of construction, such as jacking under streets. This will not only reduce the street deterioration, but will reduce the traffic impacts related to street cuts.

Public Works is requesting input from the City Council prior to moving forward with this proposal. We are available to meet with City Council members individually to answer any questions or provide additional information. We will also be extending another invitation to the local utility companies to meet with staff and discuss the proposal. Copies of all referenced studies and reports have been made available to City Council at the City Clerk's Office and are available for public review at the Public Works Department.

Based upon City Council input and subsequent meetings with the local utility companies, modifications to the proposed ordinance will be made. The finalized ordinance will then be agendized and recommended to City Council for adoption.

SECTION 2

PAVEMENT DETERIORATION STUDIES

2.1 SUMMARY OF FINDINGS

2.2 IMPACT OF UTILITY CUTS ON PERFORMANCE OF STREET PAVEMENTS - CITY OF CINCINNATI AND AMERICAN PUBLIC WORKS ASSOCIATION, 1995

2.3 THE EFFECT OF UTILITY CUTS ON THE SERVICE LIFE OF PAVEMENTS IN SAN FRANCISCO - CITY AND COUNTY OF SAN FRANCISCO, MAY 1995

2.4 THE EFFECTS OF UTILITY CUT PATCHING ON PAVEMENT PERFORMANCE IN PHOENIX, ARIZONA - CITY OF PHOENIX, ARIZONA, JULY 1990

2.5 SOUTHWEST GAS VS. CITY OF PHOENIX - BRIEF SUMMARY

2.6 SOUTHWEST GAS VS. CITY OF PHOENIX - SETTLEMENT AGREEMENT

2.7 COSTING THE EFFECTS OF UTILITY CUTS IN THE LIFE CYCLE OF ASPHALT PAVEMENTS - BURLINGTON, VERMONT, SEPTEMBER 1986

PAVEMENT DETERIORATION STUDIES
SUMMARY OF FINDINGS

A number of public agencies have completed studies which analyze the impact of utility cuts on street pavement. Four of the more significant studies have been included in this report, they are:

IMPACT OF UTILITY CUTS ON PERFORMANCE OF STREET PAVEMENT - City of Cincinnati and American Public Works Association, 1995

THE EFFECT OF UTILITY CUTS ON THE SERVICE LIFE OF PAVEMENTS IN SAN FRANCISCO - City and County of San Francisco, May 1995

THE EFFECTS OF UTILITY CUT PATCHING ON PAVEMENT PERFORMANCE IN PHOENIX, ARIZONA - City of Phoenix, Arizona, July 1990

COSTING THE EFFECTS OF UTILITY CUTS IN THE LIFE CYCLE OF ASPHALT PAVEMENTS - Burlington, Vermont, September 1986

Each of these studies sought to analyze the impacts of utility cuts on street pavement. Although these studies used various methods of evaluation and took place in a wide variety of regions across the country, all the studies concluded that utility cuts significantly reduce the life of street pavement. The impact is significant, not only at the location of the trench, but the area surrounding the excavation. **"Utility cuts produce damage that propagates beyond the area excavated; even the highest restoration standards do not remedy all the damage. Utility cuts cause the soil around the cuts to be disturbed, cause the backfilled soil to be compacted to a different degree than the soil around the cut, and produce discontinuities in the soil and wearing surface. Therefore, the reduction in pavement service life due to utility cuts is an inherent consequence of the trenching process."1**

These studies were completed by experts in the field of pavement design and maintenance, with the cooperation of local agencies, universities, and the American Public Works Association. The studies are bases on actual field cases, assessing the performance of actual trenches of various ages within streets of various ages and the performance of the pavement surrounding the trenches. The studies consistently found utility cuts to cause accelerated deterioration of the pavement.

Although all studies produced similar results, Public Works based the financial impact to the City on the results of the Phoenix study (A complete financial analysis is included in Section 3). The Phoenix study was chosen because the climate is most similar to the City of Anaheim and the City of Phoenix currently collects a street cut surcharge fee which is supported by this study. Additionally, considerable information is available regarding the Phoenix study due

to a court challenge of the street cut surcharge fee by their local gas company which resulted in an extensive discovery process.

The City of Phoenix contracted with ERES International to complete their study in response to a suit filed by Southwest Gas Corporation charging the street cut surcharge fee was excessive and unlawful. After extensive research and discovery, the case was settled in 1992 and the City of Phoenix retained the street cut surcharge fee. A summary of some of the significant points of the court case is included in this Section along with a copy of the settlement agreement

The findings of the Phoenix study supported the validity of the street cut surcharge fee and actually found the fees to be insufficient to recover the full cost associated with pavement cuts. "The results of ERES International's study in the City of Phoenix suggests that the pavement performance and the service life is directly effected by the presence of pavement cut patches. This effect was approximated by a reduction factor of 1.29 applied to the patched pavements. This life reduction coupled with the increased overlay thickness required by the higher deflections in the patched areas resulted in doubling the cost of pavement maintenance to the City for maintaining patched pavements compared to non-patched pavement."2

All of these studies clearly show that there is a significant cost for cutting pavement that goes beyond adequate trench repair.

1. The Effect of Utility Cuts on the Service Life of Pavements in San Francisco, City and County of San Francisco, May 1995

2. Affidavit of M. Y. Shahin, Ph.D., P.E., president of ERES International Inc., June 1990

Final Report

Impact of Utility Cuts on Performance of Street Pavements

by

Andrew Bodocsi
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DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the City of Cincinnati or the American Public Works Association This report does not constitute a standard, specification, or regulation

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PREFACE

The network of city streets represents one of the largest expenditures of any municipality Road surface is a key component and proper construction and maintenance are essential to continued function. A utility cut, an opening made in the pavement by a utility company to repair existing utilities or to install new services, can cause premature deterioration of the cut repair and the pavement area beyond the cut, resulting in added repair cost. Although a number of studies have been conducted, there remain many uncertainties regarding the physical effects and true cost of utility cuts.

The purpose of this document is to review past studies and to describe the two techniques developed in this study for evaluating the condition of utility cuts and surrounding pavements. The first technique is based on an objective assessment which includes deflection measurements on Asphaltic Concrete or Macadam pavements and Finite Element Analysis of Portland Cement Concrete pavements. The second technique involves subjective methodologies based on visual observation of distress. Possible methods of pavement strengthening and their estimated costs are discussed. Additionally, cost models and procedures to assess the monetary impact are presented to aid municipalities in establishing guidelines for cost recovery

This study was sponsored by the City of Cincinnati and by the American Public Works Association. It was conducted over a three-year period from 1991 into 1994 by the staff and students of the Civil and Environmental Engineering Department, Cincinnati Infrastructure Institute, University of Cincinnati, under the general supervision of Dr. Andrew Bodocsi. Principal investigators included Drs. A. Emin Aktan, Prahlad D. Pant, and Rajagopal Arudi.

IMPACT OF UTILITY CUTS ON PERFORMANCE OF STREET PAVEMENTS

EXECUTIVE SUMMARY

ABSTRACT

Many utility cuts are made annually in city street pavements by utility companies to install or inspect utility services. Although the utility companies fill up the cuts and restore the pavement sections, often it is observed that the pavement section in and around the vicinity of such cuts fail at an accelerated pace. The resulting condition has a profound influence on pavement life, maintenance cost, aesthetics, and safety of motorists. This report presents the results of a study at the University of Cincinnati to assess the damage caused by the utility cuts on the pavements. The study provides procedures for establishing the extent of damage by deflection measurements. The distress manual and the rating index called Utility Cut Condition Index developed as a part of this study assists the city managers in the maintenance of utility cuts. The existing problems related to the management of utility cuts, the methodology of the study, and a summary of the results and their implications for implementation are presented. The results of the study are synthesized in a Windows based microcomputer tool called UCMS (Utility Cut Management System). Using the user input data, the software evaluates the condition of utility cuts, computes additional cost for maintenance in the event of poor restoration and presents a report on budget requirements to upgrade the condition of a group of cuts. At present, the software works as a stand alone model. With some effort, the software can be integrated into an existing Pavement Management System.

BACKGROUND

On city street pavements, very often utility companies dig open a section of a pavement in order to install or inspect utility services, and restore it in accordance with the existing guidelines and specifications. Such a location within a pavement section is termed a 'utility cut'.

In big cities, several thousands of cuts are made every year. The cities recover a fixed amount for each cut from utility companies in the form of a permit fee (APWA Annual Meetings Proceedings, 1991). The current fee structure is not based on scientific investigation of associated costs. Of late, there is a growing concern among cities to revise the existing cost recovery policy. Such an attempt should be supported by field tests and long-term monitoring of cut pavement performance.

Recognizing the need for a scientific, reliable and yet practical approach, the University of Cincinnati in association with the City of Cincinnati and the American Public Works Association, initiated a study with the following objectives:

(i) develop field techniques appropriate for the evaluation of utility cuts based on subjective assessment (visual inspection of distresses) and objective measurement of strength (deflection);
(ii) develop cost models and procedures to assess the monetary impact of utility cuts in order to establish guidelines for recovering costs; and
(iii) develop a management system to interact and coordinate between the various phases of cut evaluation and cost recovery.

CURRENT PROCEDURES TO RECOVER THE COST OF UTILITY CUTS

During recent years, many innovative techniques have been developed for rehabilitation of distressed pavement structures. Studies on cost effectiveness of various rehabilitation strategies, for pavements that have reached a particular stage of their functional and economical life, have created a new generation of civil engineering technologies. Unfortunately, none of these studies can be directly related to evaluate the impact of utility cuts on pavement performance. In the absence of specific guidelines for assessing the life and cost impact of utility cuts, cities have developed their own fee structure, based on the experience of engineers. The fee, termed as permit fee, recovers monies for administration and inspection of cuts. The utility is charged a fixed amount for every cut pavement and for every inspection. For instance, the City of Cincinnati charges about $80 per cut. A study by the Boston Department of the Public Works revealed that administrative costs have not been updated for many years, and the current cost allocation procedures are primitive (APWA Annual Meeting Proceedings, 1991). Similar situations exist in many other cities, which puts pressure on the local governments to revise the cost recovery policy.

AMERICAN PUBLIC WORKS ASSOCIATION'S EFFORTS

In view of the need for uniform and specific guidelines, the American Public Works Association (APWA) has prepared a draft report titled 'Recovering the Costs of Pavement Cuts - Opening and Restoration' (APWA Research Foundation, 1991). The draft report presents a review of various methods of opening and restoring pavements adopted by several cities, merits and demerits of each, and cites examples of added maintenance cost due to poor restoration. However, this report does not incorporate specific guidelines for evaluating the impact of cuts and establishing a cost recovery policy.

DEVELOPMENT OF FIELD EVALUATION TECHNIQUES

The study carried out at the University of Cincinnati examined several methods of evaluating impact of utility cuts on:

(i) Strength characteristics (deflection measurements using Dynaflect, FWD, Benkelman Beam) and
(ii) Surface characteristics (visual inspection).

The methodology adopted in this study is presented in the form of a flow chart in Fig. 1. Strength evaluation comprised of deflection measurements in and around the cuts in asphalt and concrete pavements. Initial survey of surface condition of cuts in concrete pavements revealed that there were no visible distresses and the cuts were in good condition. Hence, the visual condition survey was limited only to cuts in asphalt surfaced pavements.

Size of Cuts

The size of cuts to be evaluated is generally small in comparison with those of the surrounding pavements. Pavements are assumed to have infinite dimensions in the horizontal direction, hence the boundary influence will be ignored. On the other hand, cuts have a finite size, which will have a significant effect on the performance of the pavement in and around the cut. Therefore, identifying a representative size of cuts was important to plan the field evaluation studies.

To this end, a survey was carried out to determine the distribution of size of utility cuts on pavements in Cincinnati. The results indicated that the average size of the utility cuts is 5 feet by 4 feet.

Strength Tests

The results of the detailed studies indicated that the measurement of the deflection profile on asphalt pavements is not necessary for routine evaluation of cuts. Instead, one-point deflection measurements would be sufficient. Hence, the deflection measurement process has been simplified by using a Benkelman Beam, and measuring only the maximum deflection under a truck wheel load. However, it should be realized that, the measurement of deflection profile would give a more detailed assessment of the overall condition of a cut, when necessary.

The deflection tests were carried out in two phases. The first phase involved a comprehensive study around typical utility cuts to find the areal extent of pavement weakening, and the critical points for deflection measurement. The second phase involved routine measurement of deflections at the critical points, as identified in the

first phase. Deflection measurements were made at closer intervals near the cut and on a control point at a distance of 2.4m (8 feet) away from the edge of the cut. This control point assumed to be in a zone of no influence. The deflections measured in and around the cut, was utilized to establish the extent of influence. In all, 36 cuts were tested in the first phase. A statistical analysis of this data was made to establish the extent of area influenced by the cuts, based on the deflection values. The results indicated that the average extent of damage extends to 0.9m (3 feet) from the edges of the cut (Bodocsi, Arudi and Keiser, 1993). In addition, the maximum deflection at the center or the edge of the cut, whichever was higher, was compared with the deflection measured at the control point.

On cuts in concrete pavements, deflection measurements were made using a Falling Weight Deflectometer. A finite element model was developed to compute the stresses and strains in the concrete slabs at critical locations. The analytical study aimed at identifying critical locations of a cut within a slab. The results show that cuts in 9 inch thick slabs are generally not damaging, unless they are near the curb.

Distress Manual, Distress Surveys and Rating Index

A Distress Identification Manual for Utility Cuts (University of Cincinnati, Cincinnati Infrastructure Institute, 1991) was developed to familiarize the engineers and inspectors with possible distresses in and around utility cuts and provide guidelines for identifying the distresses and estimating their severity levels.

In all, 75 cuts on asphalt pavements were surveyed by a team of 15 engineers and highway maintenance inspectors. The engineers and inspectors were asked to fill out an Evaluation Form for each cut. The Evaluation Form (Fig. 2) was designed to extract information on the type and severity of distresses present in and around the cuts. The engineers and inspectors were also asked to recommend an action for maintenance. It was observed that with proper training, the information required in the Evaluation Form could be collected at each site in about 5 minutes.

Prior to the distress survey, the team of engineers and inspectors were trained for distress evaluation. As a training tool, the Delphi Method was used. This method assisted in reducing variations in the opinions among panel members by allowing them to reconsider their previous opinions based on the summary of opinions of all members in the panel. The information obtained from the distress survey was processed in an Artificial Neural Network (Pant et al., 1993) and a rating index called 'Utility Cut Condition Index' (UCCI) was developed.

COST ANALYSIS

The study indicated that the cuts made in concrete pavements in Cincinnati do conform to the strength requirements and do not need additional strengthening. However, the cuts in asphalt pavements were found to require additional strengthening. Based on the maximum deflections in and around the cuts and that at the control point, the required average overlay thickness was computed to bring the pavement up to its original strength. For the asphalt surface pavements, this was found to be 1.15 inch. For a cut with an average size of 5 ft. by 4 ft., the cost of this strengthening was found to be a minimum of $950. This cost inciuded the expense of grinding off part of the old pavements, hauling of material and the cost of placing the new high-strength overlay. For the City of Cincinnati, where approximately 6000 cuts are made in asphalt pavements, the total yearly cost to be recovered could amount to $2,000,000. However, it should be pointed out that these figures are based on limited data and further work is necessary to refine the computations.

UTILITY CUT MANAGEMENT SYSTEM (UCMS)

The UCMS is a synthesis of field evaluation procedures, cost management, and policy issues related to maintenance of utility cuts. The goals of UCMS are:

(i) To identify the method most useful for evaluating performance of utility cuts;
(ii) To differentiate between the quality of restoration by different utilities/sub-contractors;
(iii) To generate a comprehensive database;
(iv) To develop statistically calibrated models to predict future performance, life-cycle cost and monetary impact;
(v) To address issues related to planning, investments and maintenance activities.

An MS-Windows based software (UCMS Ver. 1.0) has been developed for the implementation of UCMS.

Evaluating Maintenance Requirements

The deflection data is used in the computation of overlay thickness. If the deflection at any point within or near the cut is greater than the deflection at the control point, an overlay is recommended and the overlay thickness required for the excess deflection is computed by the Asphalt Institute Method. In the event that deflection data is not available, the recommendation on maintenance and rehabilitation action made by the engineers and inspectors during the distress survey based on the UCCI value is used.

Cost of Maintenance and Rehabilitation (M&R) Action

The model considers labor, material and equipment costs to compute the total cost of a given M&R action. A facility has been provided to update the costs with the changing market prices. The program computes the total cost to upgrade a cut over its entire area plus an area of pavement influenced by the cut.

IMPLEMENTATION

Deflection measurements at or near the critical locations will be used as the criteria for estimating the extent of damage and the cost to be recovered. The rating index, UCCI, will serve as a management tool to identify the time at which remedial action is to be implemented. For instance, the deflection measurement may indicate a poor structural condition of the pavement at the time of measurement. However, the surface condition of the cut could still be acceptable, which may cause the engineers to defer any remedial action. But, if the strengthening of the pavement is deferred, a continual deterioration will take place with time and will require a thicker overlay in the future. Hence, the UCCI can be used to identify the time when a remedial action will be required.

The UCMS considers all important facets of damage assessment, cost recovery, maintenance program, consequences of deferred maintenance, and viable actions.

SUMMARY OF TASKS FOR MANAGEMENT SYSTEM

The utility cut management system, will comprise the following tasks, performed by a participating city:

1. Choose a random sample of typical utility cuts
2. Conduct a comprehensive study to establish the typical aerial extent of weakened pavement around cuts
3. Make deflection measurements on each selected cut at critical locations
4. Compute the overlay thickness required to bring the cut and the influenced area of pavement up to the strength of the unaffected original pavement
5. Compute the typical cost of overlay
6. Bill the utility companies for the cost determined and deposit the money in an escrow account
7. Visually inspect the sample cuts every other year. Assess their structural condition, determine UCCI and enter into the database
8. Use the management system to suggest the most appropriate repair action, time and the probable technical and economic consequence